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MACROLEPIDOPTERAN MOTHS LIGHT-TRAPPED IN A NEW JERSEY OAK FOREST (LEPIDOPTERA)

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Abstract.—Light trapping was conducted for five years in a virgin oak forest on the New Jersey Piedmont Plateau. A total of 410 species of moths were recorded from 14 families. This includes about a third of all the species of macrolepidopteran moths recorded in New Jersey. The total catch of each species is listed, and the species are ranked within family by abundance. The most abundant species, *Lithacodia carneola* Gn., represented about 8% of the total catch, and the top 15 species represented about 50%.

A five year study was conducted to quantify the taxonomic structure and phenology of the moth community in a small forest in central New Jersey. The objectives of the study were to examine ecological aspects of the community and to evaluate the stability of the community in the wake of an expected gypsy moth outbreak. The latter did not materialize (Moulding, 1977), but the first objective has been achieved.

This paper describes the taxonomic composition of the macrolepidopteran moths collected by light-trapping in the forest from 1973 to 1977 during the seasons extending from early March to mid-October.

METHODS AND RESULTS

The collecting site was Hutcheson Memorial Forest (HMF), located on the New Jersey Piedmont Plateau near the town of East Millstone, Somerset County (40°30′N, 74°34′W). It is a mature (over 250 years old), mixed-oak forest of 65 acres surrounded by old fields in various stages of abandonment and cultivated fields of corn, soybean and winter rye. Monk (1961) characterized the upland part of the forest (82% of the area) as having a mixed-oak canopy, flowering dogwood understory and maple-leaved viburnum shrub layer. Frei and Fairbrothers (1963) in an extensive inventory of the flora of the forest and edge recorded 40 species of trees, 39 of shrubs and 232 of herbs; 71 of the total were considered exotic (non-native) species. The forest is believed to have had a minimum of human interference since

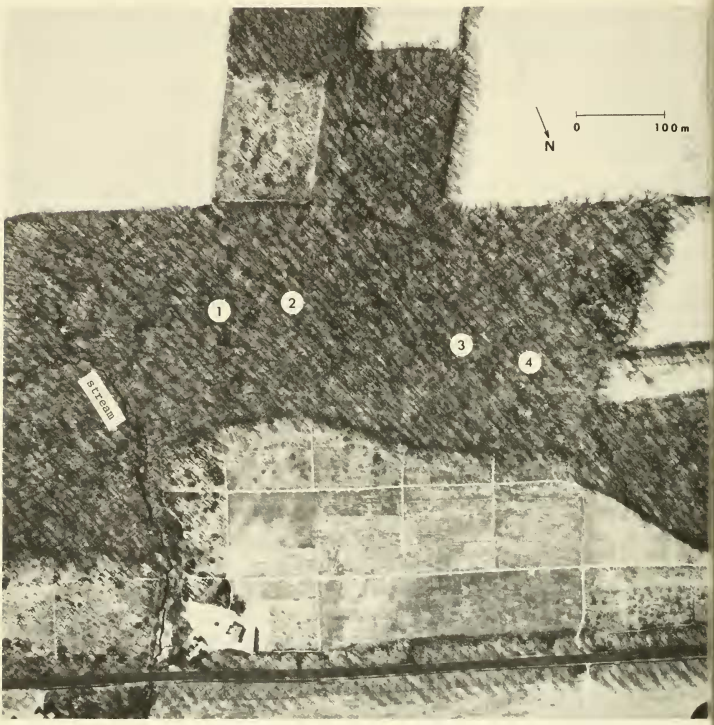

Fig. 1. Moth light-trap sampling sites. (Aerial photography flown on 9 February 1976.)

colonial times. No fires or significant cutting have apparently occurred since the early 1700's. Under Rutgers' study since 1948 and ownership since 1955 it has been established as an ecological preserve; and insecticides are known never to have been applied.

Moths were collected by four 6-watt, photo-cell-controlled, UV light traps (Ellisco Co., Philadelphia, Pennsylvania) located at permanent sampling sites in the central part of the forest (Fig. 1). A weekly sampling regime was established, and the nights were chosen to avoid rain, wind and unseasonably low temperatures in order to minimize non-seasonal environmental variables. Moon effects were avoided as much as possible by choosing cloudy nights when practical. Collections were made during the years 1973-

Table 1. Seasonal sampling intensity.

	Total number of nights trapped		
	Early	Mid	Late
March	2	1	2
April	0	3	2
May	2	2	3
June	2	4	2
July	5	5	7
August	5	5	4
September	5	3	3
October	4	3	0

1977, with the collecting season varying somewhat from year to year as shown in Table 1. In 1973, all traps were placed at a height of 1.8 m above the ground. During the remaining years, the middle two traps were raised on pulleys attached to white oaks to a height of 18 m.

Moths were identified by comparison with specimens in the insect museum of the Rutgers' Department of Entomology and Economic Zoology, and voucher specimens from the trapping were put into the collection. Only moths belonging to the division Macrolepidoptera were tallied by species.

From a total of 293 trap-nights, 22,880 individual moths were collected and represented 410 species in 14 families. These are listed by family in Table 2; the species within a family are ranked in decreasing order of abundance. Scientific nomenclature is based on McDunnough (1938) as amended in recent years.

Discussion

Exclusive of sub-species and infrasub-specific variants, there are 1258 species of macrolepidopteran moths recorded from New Jersey (Smith, 1909; Muller, 1965, 1968, 1973, 1976). Some of the species listed by Smith may have since been extirpated in New Jersey due to habitat destruction; other species are being added to the record at a rate of about 10 per year by Muller, who to our knowledge is the only New Jersey worker active in this area. The present study adds six new species to the published record of New Jersey species. Five of these are represented by New Jersey specimens already in the Rutgers' insect museum and so have probably been merely overlooked or confused with closely related species in the past. Our specimen of *Callopistria floridensis* Gn. is to our knowledge the first record for New Jersey. This, however, is not ecologically significant since it is described as a sometimes-greenhouse-pest from Florida and thus it probably is not viable as a resident in the New Jersey climate.

Table 2. Listing by family of species caught in forest traps. Species are ranked within family in order of decreasing abundance.

Species	Total Catch	Species	Total Catch
NOCTUIDAE		*Graphiphora badinodis* Grt.	33
		Philometra eumelusalis Wlk.	33
Lithacodia carneola Gn.	1565	*Tarachidia candefacta* Hbn.	33
L. muscosula Gn.	619	*Hormisa orciferalis* Wlk.	32
Graphiphora c-nigrum L.	465	*Leucania ursula* Forbes	31
Ogdoconta cinereola Gn.	313	*Phalaenostola larentioides* Grt.	31
Palthis asopialis Gn.	284	*Platysenta videns* Gn.	31
Zanclognatha cruralis Gn.	282	*Tetanolita floridana* Sm.	31
Agrotis ypsilon Rott.	237	*Amphipyra pyramidoides* Gn.	30
Spragueia leo Gn.	186	*Catocala micronympha* Gn.	30
Ochropleura plecta L.	180	*Apamea americana* Speyer	27
Cosmia calami Harv.	175	*Galgula partita* Gn.	27
Phoberia atomaris Hbn.	171	*Orthosia rubescens* Wlk.	27
Anorthodes tarda Gn.	143	*Metaxagloea inulta* Grt.	26
Plathypena scabra Fabr.	140	*Elaphria versicolor* Grt.	25
Pseudaletia unipuncta Haw.	139	*Zale horrida* Hbn.	24
Euplexia benesimilis L.	116	*Crocigrapha normani* Grt.	22
Xanthoptera nigrofimbria Gn.	110	*Orthodes crenulata* Butl.	22
Epizeuxis aemula Hbn.	102	*Acronicta exilis* Grt.	21
Palthis angulalis Hbn.	95	*Autographa precationis* Gn.	21
Papaipema marginidens Gn.	93	*Caenurgina crassiuscula* Haw.	21
Orthosia hibisci Gn.	91	*Leuconycta diphteroides* Gn.	21
Papaipema harrisi Grt.	89	*Papaipema impecuniosa* Grt.	21
Orthodes cynica Gn.	86	*Leucania multilinea* Wlk.	20
Lacinipolia renigera Steph.	82	*Neoerastria apicosa* McD.	19
Cerastis tenebrifera Wlk.	78	*Polygrammate hebraeicum* Hbn.	19
Phalaenophana pyramusalis Wlk.	75	*Renia factiosalis* Wlk.	19
Tarachidia erastrioides Gn.	73	*Leucania phragmatidicola* Gn.	18
Catocala amica Hbn.	67	*Panopoda rufimargo* Hbn.	17
Zanclognatha pedipilalis Gn.	66	*Rivula propinqualis* Gn.	15
Bomolocha baltimoralis Gn.	58	*Schinia arcigera* Gn.	15
Pseudorthodes vecors Gn.	58	*Tricholita signata* Wlk.	15
Lithacodia synochitis G. & R.	57	*Catocala ultronia* Hbn.	14
Elaphria grata Hbn.	56	*Peridroma margaritosa* Haw.	14
Sunira bicolorago Gn.	55	*Procus modica* Gn.	14
Lascoria ambigualis Wlk.	54	*Spargaloma sexpunctata* Grt.	14
Nephelodes emmedonia Cram.	52	*Psaphida grotei* Morr.	13
Acronicta modica Wlk.	47	*Redectis vitrea* Grt.	13
Zanclognatha jacchusalis Wlk.	46	*Zanclognatha lituralis* Hbn.	13
Choephora fungorum G. & R.	42	*Graphiphora bicarnea* Gn.	12
Zanclognatha ochreipennis Grt.	40	*Proxenus miranda* Grt.	12
Renia salusalis Wlk.	38	*Balsa malana* Fitch	11
Spodoptera ornithogalli Gn.	35	*Orthosia revicta* Morr.	11
Graphiphora smithi Snell	34	*Paectes oculatrix* Gn.	11
Protolampra brunneicollis Grt.	34	*Zanclognatha protumnusalis* Wlk.	11
Epizeuxis americalis Gn.	33	*Epizeuxis lubricalis* Geyer	10

Table 2. *Continued.*

Species	Total Catch	Species	Total Catch
Rhynchagrotis anchocelioides Gn.	10	*Farontia diffusa* Wlk.	4
Achatodes zeae Harr.	9	*Feltia subgothica* Haw.	4
Feltia ducens Wlk.	9	*Harrisimemna trisignata* Wlk.	4
Lithophane antennata Wlk.	9	*Morrisonia evicta* Grt.	4
Stirioides obtusa H.-S.	9	*Nedra ramosula* Gn.	4
Zanclognatha laevigata Grt.	9	*Pangrapta decoralis* Hbn.	4
Agrapha aerea Hbn.	8	*Zale lunata* Dru.	4
Amolita fessa Grt.	8	*Z. lunifera* Hbn.	4
Baileya levitans Sm.	8	*Acronicta hasta* Gn.	3
Chamyris cerintha Treit.	8	*Agroperina dubitans* Wlk.	3
Eupsilia sidus Gn.	8	*Catocala andromedae* Gn.	3
Phosphila turbulenta Hbn.	7	*Cryphia villificans* B. & McD.	3
Renia discoloralis Gn.	7	*Lacinipolia lorea* Gn.	3
Scolecocampa liburna Geyer	7	*Leucania pseudargyria* Gn.	3
Spodoptera frugiperda J. E. Smith	7	*Papaipema cerussata* Grt.	3
Acronicta afflicta Grt.	6	*P. nebris* Gn.	3
Agrotis venerabilis Wlk.	6	*Procus exhausta* Sm.	3
Chytolita morbidalis Gn.	6	*P. mactata* Gn.	3
Epidelta metonalis Wlk.	6	*Schinia marginata* Haw.	3
Eupsilia morrisoni Grt.	6	*Zale aeruginosa* Gn.	3
Feltia herilis Grt.	6	*Acronicta caesarea* Sm.	2
Hyppa xylinoides Gn.	6	*Anagrapha falcifera* Kby.	2
Leucania commoides Gn.	6	*Anticarsia gemmatilis* Hbn.	2
Marathyssa inficita Wlk.	6	*Baileya dormitans* Gn.	2
Metalectra discalis Grt.	6	*B. opthalmica* Gn.	2
Mocis texana Morr.	6	*Bomolocha toreuta* Grt.	2
Parallelia bistriaris Hbn.	6	*Catocala connubialis* Gn.	2
Platysenta vecors Gn.	6	*C. ilia* Cram.	2
Polia subjuncta G. & R.	6	*Celiptera frustulum* Gn.	2
Pyreferra hesperidago Gn.	6	*Charadra deridens* Gn.	2
Amphipyra tragopoginis L.	5	*Eucirrhoedia pampina* Gn.	2
Bleptina caradrinalis Gn.	5	*Euherrichia monetifera* Gn.	2
Catocala grynea Cram.	5	*Heliothis zeae* Harr.	2
Eueretagrotis sigmoides Gn.	5	*Isogona natatrix* Gn.	2
Graphiphora tenuicula Morr.	5	*Leucania linita* Gn.	2
Hormisa litophora Grt.	5	*Lithophane hemina* Grt.	2
Perigea xanthioides Gn.	5	*L. laticinerea* Grt.	2
Zale lineosa Wlk.	5	*L. petulca* Grt.	2
Acronicta haesitata Grt.	4	*Morrisonia confusa* Hbn.	2
A. ovata Grt.	4	*Panopoda carneicosta* Gn.	2
Apamea velata Wlk.	4	*Papaipema duovata* Bird	2
Baileya australis Grt.	4	*Parathisanotia grata* Fabr.	2
Balsa labecula Grt.	4	*Plusiodonta compressipalpis* Gn.	2
B. tristrigella Wlk.	4	*Polia distincta* Hbn.	2
Chytonix palliatricula Gn.	4	*Procus crytora* Franc.	2
Crambodes talidiformis Gn.	4	*Renia flavipunctalis* Geyer	2
Cryphia pervertens B. & McD.	4	*Schinia lynx* Gn.	2

Table 2. *Continued.*

Species	Total Catch	Species	Total Catch
Spodoptera exigua Hbn.	2	*Protocryphia secta* Grt.	1
Tetanolita mynesalis Wlk.	2	*Protorthodes oviduca* Gn.	1
Ulolonche culea Gn.	2	*Psaphida resumens* Wlk.	1
Zale galbanata Morr.	2	*Pseudeva purpurigea* Wlk.	1
Acontia aprica Hbn.	1	*Pseudoplusia oo* Cram.	1
Acronicta americana Harr.	1	*Pyrrhia umbra* Hufn.	1
A. brumosa Gn.	1	*Raphia frater* Grt.	1
A. interrupta Gn.	1	*Schinia nundina* Dru.	1
A. lithospila Grt.	1	*S. obscurata* Stkr.	1
A. vinnula Grt.	1	*Xylomyges alternans* Wlk.	1
Agriopodes teratophora H.-S.	1	*Xystopeplus rufago* Hbn.	1
Allotria elonympha Hbn.	1	*Zale minerea* Gn.	1
Anaplectoides prasina Schiff.	1	GEOMETRIDAE	
Anathix ralla G. & R.	1	*Nematocampa limbata* Haw.	1354
Bomolocha bijugalis Wlk.	1	*Hypagyrtis subatomaria* Wood	953
Caenurgina erechtea Cram.	1	*Eupithecia miserulata* Grt.	850
Callopistria floridensis Gn.	1	*Itame pustularia* Gn.	607
Catabena lineolata Wlk.	1	*Pero honestarius* Wlk.	530
Catocala gracilis Edw.	1	*Anacamptodes ephyraria* Wlk.	446
C. minuta Edw.	1	*Eugonobapta nivosaria* Gn.	398
C. muliercula Gn.	1	*Anavitrinella pampinaria* Gn.	365
Chytolita petrealis Grt.	1	*Xanthorhoe lacustrata* Gn.	287
Cucullia asteroides Gn.	1	*Hyperetis nepiasaria* Wlk.	266
Dypterygia scabriuscula L.	1	*Bapta vestaliata* Gn.	221
Epizeuxis denticulalis Harv.	1	*Nycterosea obstipata* Fabr.	174
E. forbesi French	1	*Hyperetis amicaria* H.-S.	167
Euagrotis illapsa Wlk.	1	*Lygris diversilineata* Hbn.	134
Eurois occulta L.	1	*Abbottana clemataria* J. E. Smith	125
Euthisanotia unio Hbn.	1	*Pleuroprucha insulsaria* Gn.	117
Feltia annexa Treit.	1	*Campaea perlata* Gn.	116
Graphiphora normaniana Grt.	1	*Cosymbia packardaria* Prout	115
Haploolophus mollissima Gn.	1	*Ectropis crepuscularia* Schiff.	113
Heptagrotis phyllophora Grt.	1	*Nemoria bistriaria* Hbn.	111
Hypsoropha hormos Hbn.	1	*Scopula limboundata* Haw.	100
Lacinipolia meditata Grt.	1	*Phigalia denticulata* Hulst	94
Ledaea perditalis Wlk.	1	*Melanolophia canadaria* Gn.	90
Lithacodia musta G. & R.	1	*Euphyia centrostrigaria* Woll.	88
Lithophane bethunei G. & R.	1	*Prochoerodes transversata* Dru.	86
Loxagrotis acclivis Morr.	1	*Synchlora aerata* Fabr.	85
Metalectra tantillus Grt.	1	*Xanthotype sospeta* Dru.	69
Paectes abrostoloides Gn.	1	*Metarranthis homuraria* Grt.	59
Papaipema maritima Bird	1	*Melanolophia signataria* Wlk.	58
Phlogophora periculosa Gn.	1	*Ennomos subsignarius* Hbn.	57
Phosphila miselioides Gn.	1	*Tetracis cachexiata* Gn.	53
Polia adjuncta Bdv.	1	*Euchlaena decisaria* Wlk.	44
P. detracta Wlk.	1	*Plagodis fervidaria* H.-S.	44
Procus fractilinea Grt.	1		

Table 2. *Continued.*

Species	Total Catch
Epimecis hortaria Fabr.	43
Timandra amaturaria Wlk.	38
Chlorochlamys chloroleucaria Gn.	37
Antepione thisoaria Gn.	36
Xanthorhoe ferrugata Clerck.	35
Apicia confusaria Hbn.	33
Besma quercivoraria Gn.	28
Phigalia titea Cran.	27
Sicya macularia Harr.	25
Hyperetis alienaria H.-S.	24
Cosymbia pendulinaria Gn.	23
Paleacrita vernata Peck	23
Orthofidonia tinctaria Wlk.	19
Euchlaena serrata Dru.	16
Heterophleps triguttaria H.-S.	16
Phigalia strigataria Minot	16
Euchlaena amoenaria Gn.	15
Scopula inductata Gn.	13
Dichorda iridaria Gn.	11
Haematopis grataria Fabr.	11
Dyspteris abortivaria H.-S.	8
Metarranthis hypochraria H.-S.	8
Neodezia albovittata Gn.	8
Itame coortaria Hulst	7
Semiothisa aemulataria Wlk.	7
Anacamptodes larvaria Gn.	6
Biston betularia Gn.	6
Euchlaena johnsonaria Fitch	6
Hydrelia albifera Wlk.	6
Semiothisa multilineata Pack.	6
Plagodis phlogosaria Pears.	5
Protoboarmia porcelaria Gn.	5
Sterrha demissaria Hbn.	5
Syssaura puber G. & R.	5
Anacamptodes humaria Gn.	4
Coryphista meadi Pack.	4
Euphyia intermediata Gn.	4
Lytrosis unitaria H.-S.	4
Deuteronomus magnarius Gn.	3
Eupithecia spp.	3
Metarranthis broweri Rupert	3
Tetracis crocallata Gn.	3
Thysanopyge gausaparia Grt.	3
Heliomata cycladata Grt.	2
Horisme intestinata Gn.	2
Mellilla xanthometata Wlk.	2
Plagodis alcoolaria Gn.	2
P. phlogosaria Gn.	2
Semiothisa continuata Wlk.	2
S. ocellinata Gn.	2
Anagoga occiduaria Wlk.	1
Chlorissa pistasciaria Gn.	1
Earophila vasiliata Gn.	1
Eubaphe mendica Wlk.	1
Euchlaena irraria B. & McD.	1
Hydriomena pluviata Gn.	1
Lambdina athasaria Wlk.	1
Metarranthis duaria Gn.	1
M. obfirmaria Hbn.	1
Nyrdria prunivorata Ferg.	1
Paleacrita merriccata Dyar.	1
Priocycla armataria H.-S.	1
Protitame virginalis Hlst.	1
Semiothisa bisignata Wlk.	1
Tornos scolopacinarius Gn.	1
NOTODONTIDAE	
Heterocampa guttivitta Wlk.	202
H. biundata Wlk.	164
Nadata gibbosa J. E. Smith	89
Lophodonta angulosa J. E. Smith	34
Schizura unicornis J. E. Smith	10
Oligocentria lignicolor Wlk.	9
Heterocampa manteo Dbldy.	7
Schizura ipomoeae Dbldy.	6
Heterocampa varia Wlk.	5
Datana contracta Wlk.	4
Hyperaeschra georgica H.-S.	4
Nerice bidentata Wlk.	4
Fentonia marthesia Cram.	3
Symmerista canicosta Franc.	3
Gluphisia septentrionalis Wlk.	2
Schizura leptinoides Grt.	2
S. semirufescens Wlk.	2
Datana integerrima G. & R.	1
D. major G. & R.	1
Ellida caniplaga Walk.	1
Heterocampa bilineata Pack.	1
Ichthyura albosigma Fitch	1
Schizura badia Pack.	1
ARCTIIDAE	
Halisidota tessellaris J. E. Smith	997
Diacrisia latipennis Stretch	187

Table 2. *Continued.*

Species	Total Catch	Species	Total Catch
D. virginica Fabr.	115	*M. disstria* Hbn.	105
Cycnia tenera Hbn.	90	*Tolype velleda* Stoll.	48
Estigmene congrua Wlk.	71	DREPANIDAE	
Euchaetias egle Dru.	41		
Eubaphe opella Grt.	38	*Oreta rosea* Wlk.	32
Isia isabella J. E. Smith	33	*Drepana arcuata* Wlk.	2
Hyphantria textor Harr.	6	*Eudeilinia herminiata* Gn.	2
Apantesis phalerata Harr.	5	THYATIRIDAE	
A. virgo L.	2		
Hyphantria cunea Dru.	2	*Euthyatira pudens* Gn.	3
Crambidia pallida Pack.	1	*Pseudothyatira cymatophoroides* Gn.	2
C. uniformis Dyer	1	*Habrosyne scripta* Gosse	1
Cycnia inopinatus Hy. Edw.	1	SATURNIIDAE	
Phragmatobia assimilans Wlk.	1		
P. lineata Donahue	1	*Automeris io* Fabr.	3
		Actias luna L.	1
SPHINGIDAE		*Antheraea polyphemus* Cram.	1
		Dryocampa rubicunda Fabr.	1
Paonias excaecatus J. E. Smith	18		
P. myops J. E. Smith	7	NOLIDAE	
Ceratomia undulosa Wlk.	6		
Deidamia inscripta Harr.	4	*Sarbena minuscula* Zell.	186
Cressonia juglandis J. E. Smith	1	*Celama triquetrana* Fitch	3
Darapsa pholus Cram.	1	APATELODIDAE	
Eumorpha satellitia L.	1		
		Olceclostera angelica Grt.	85
LYMANTRIIDAE		*Apatelodes torrefacta* J. E. Smith	5
		EPIPLEMIDAE	
Lymantria dispar L.	328		
Orgyia leucostigma A. & S.	255		
O. definita Pack.	10	*Calledapteryx dryopterata* Grt.	155
LASIOCAMPIDAE		CTENUCHIDAE	
Malacosoma americana Fabr.	413	*Cisseps fulvicollis* Hbn.	90

The relative abundance of each species as shown in Table 2 must be interpreted with some caution. Sampling intensity and trapping efficiency were not equal at all seasons. Temperature was the most important uncontrolled environmental factor affecting the size of the catch. During the fall and early spring, night temperatures often fell below the 5°C (40°F) activity threshold. The adequacy of the catch as a proportional representation of the existing moth community therefore depended upon the ability to capitalize on the few and randomly occurring warm nights during these seasons. If there was snow cover, any winter moths dormant in the leaf litter would be prevented from flying even if the air temperature was high enough. Late fall

moths may not have been adequately sampled. Trapping was discontinued in mid-October when the hunting (poaching) season began and falling leaves tended to block the trap funnels. This was too early to catch the fall cankerworm (*Alsophila pometaria* Harr.) which is known to be present in the forest. It should be recognized also that, while almost all moths will come to light, they may have differential responses to the attraction such that trapping efficiency would vary among the species. This has been demonstrated for the *Catocala* (Sargent, 1976).

It is difficult to delineate the exact physical boundaries of the community from which the species in this study were drawn. The placement of the traps, a minimum of 100 m back from the edges of the surrounding fields, undoubtedly limited the catch to the moths present in the forest. The lights were not visible from the fields during most of the season, and the attractant range of even larger blacklight traps has been found not to exceed 30 m (Hartstack et al., 1971). However, a number of the species caught are wide-ranging migrants; and others may have been blown into the forest from other habitats, thereby being non-residents of the community within the forest. Occurrences with strong stochastic elements such as these contribute in part to the tally of species represented by only one individual.

An analysis of the comparative richness of the HMF community is hampered by the lack of available studies in similar environments. The closest known study is one conducted for four years at Orono, Maine over a shorter season but with somewhat greater sampling intensity (Dirks, 1937). From 56,131 specimens, Dirks recorded 344 species of macrolepidopteran moths, 120 of which are shared with the HMF community. Williams (1939), collected 356 species involving 76,755 specimens at Rothamsted, England over four years. Preston (1948) gives data for two other unpublished moth light-trapping studies: King in Saskatchewan, Canada reported 277 species from 87,110 specimens over 22 years; and Seaman in Alberta, Canada reported 291 species from 303,251 specimens over 22 years. The greater species richness of the HMF collection may be directly or indirectly attributable to the warmer climate and greater plant species diversity of the eastern North American deciduous forest biome.

Acknowledgments

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